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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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AD-A196 867

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFIT/CI/NR 88-66	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): HISTORICAL EXAMINATION OF ACCIDENTS WITHIN THE U.S. ARMY CORPS OF ENGINEERS	5. TYPE OF REPORT & PERIOD COVERED: MS THESIS
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): DEREK C. BROWN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: AFIT STUDENT AT: UNIVERSITY OF WASHINGTON	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: 1988
	13. NUMBER OF PAGES: 67
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): AFIT/NR Wright-Patterson AFB OH 45433-6583	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

DISTRIBUTED UNLIMITED: APPROVED FOR PUBLIC RELEASE

DTIC ELECTE AUG 0 4 1988 S D

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

SAME AS REPORT

18. SUPPLEMENTARY NOTES

Approved for Public Release: IAW AFR 190-1
LYNN E. WOLAVER 19 Jul 88
Dean for Research and Professional Development
Air Force Institute of Technology
Wright-Patterson AFB OH 45433-6583

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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An Abstract of the Report Titled:

A Historical Examination of Accidents Within the U.S. Army Corps of Engineers

By

Derek C. Brown

This report examined U.S. Army Corps of Engineers accident records for the period 1977 to 1983. Included in the subject analyses were examinations of property damages associated with an accident (by severity of the injury and geographic location), time of accident occurrence (by severity of the injury and geographic location), accident incidence rates by geographic location, and severity of injuries by phase of construction in which accidents occurred.

Analysis of property damages by severity or geographic region revealed no conclusive finding. Analysis of times of accident occurrence revealed that most accident distributions tended to follow the "classic" distribution suggested by Hinze (1981), except accidents that occurred during other-than-normal work hours and fatalities that occurred within the continental United States. Analysis of accident incidence rates by geographic region revealed no conclusive finding. Analysis of accidents by phase of construction revealed that several phases of construction appear to experience a disproportionate number of fatalities as well as a higher percentage of fatalities.

Keywords: Army accident reports; theses; (KT)

A Historical Examination of Accidents Within the U.S. Army Corps of Engineers

by

DEREK C. BROWN

A report submitted in partial fulfillment
of the requirements for the degree of

Master of Science

University of Washington

1988

Approved by______________________________
(Chairperson of Supervisory Committee)

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Program Authorized
to Offer Degree______________________________

Date______________________________

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ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to everyone who contributed to the realization of this document: to my parents for their love, support, and assistance; to the Army Corps of Engineers Department of Occupational Safety and Health in Seattle for their assistance in acquiring and interpreting the accident data; and to Professor Jim Hinze for his guidance and infinite patience. In addition, special thanks to Roger Humberson for solving most of the computer problems, and for his efforts in acquiring the information that made this entire research effort possible. Thanks.

Introduction

Concern for the safety of workers is a logical consequence of the organized labor movement, and has evolved gradually with the maturation of our economy and society as a whole. Worker safety can also be interpreted as a reflection of societal values, such as the perceived importance of an individual relative to the task at hand. One cannot concede that all countries participating in the international marketplace hold the same societal values regarding worker safety, and by the same token one cannot profess the equal status of labor movements within all countries. One might hypothesize how these differences impact the safety records of construction contractors from one country to the next.

Competition within the international marketplace requires provision of a quality product, an inexpensive product, or some ideal combination of the two. The construction industry, where competitive bidding is the standard, is exemplary of the quest for the ideal combination of quality and price. Rewards accrue only to those contractors who can attain the specified degree of quality at a price lower than their competitors.

While some contractors endeavor to maximize profits through improved construction techniques or creation of situational advantages, others search for a shortcut in place of genuine innovation. In the latter instance, worker safety is often

alleged as being one of the first areas to be compromised. Unscrupulous contractors might perceive safety measures as superfluous requirements that contribute nothing to the completion of the project at hand, while simply detracting from potential profits.

Various measures have been undertaken within the United States to prevent the unnecessary endangerment and exploitation of workers, ranging from labor strikes to litigation to enactment of the Occupational Safety and Health Act (OSHA). Factors contributing to the heightened level of safety consciousness, characteristic of the modern work environment, include the prospect of litigation, imposition of penalties by agencies such as those created under OSHA, and the moral development of individuals within the construction industry.

A consequence of this heightened degree of consciousness regarding worker safety has been the advent of agencies commissioned with the task of assembling safety statistics. The Occupational Safety and Health Administration, for example, has been delegated the responsibility for development of injury and illness statistics within the construction industry (Dept. of Labor, 1971). The Army Corps of Engineers also maintains within its structure a Department of Occupational Safety and Health, dedicated to the promotion of safety within the work force for which it is responsible, and the further analysis of relevant safety information. Some of the larger private concerns also

maintain entire divisions within their corporate structures dedicated to the promotion of safety within the workplace and the independent development of safety statistics.

Some agencies, however, remain hindered in their efforts to integrate safety into the workplace through study and analysis of statistics. In some instances this may be the result of a conscious decision based on a lack of genuine concern for worker safety, or a lingering belief that it is not cost-effective to integrate safety into the workplace. In other instances, competing financial interests may preclude the complete analysis of data that has been compiled. In either case, the end result is that while safety statistics may have been assembled, there is no guarantee that they will be used to fulfill the purpose for which they were collected, namely the enhancement and improvement of worker safety and its integration into the workplace.

The purpose of this report is to demonstrate a methodology by which existing injury data can be analyzed to provide meaningful feedback. This report further endeavors to present results that may be of benefit to the construction industry as a whole and generate interest in the further study and promotion of safety in the construction workplace.

Literature Review

A review of literature pertaining to construction accidents revealed that in spite of current efforts to promote safety within the construction industry, shortcomings persist that result in thousands of injuries each year, many of them fatal.

The National Safety Council estimates that the construction industry employs approximately 5 million workers (5 % of the industrial workforce) and incurs approximately 20 percent of the industrial fatalities. While death rates declined from 1976 to 1985, construction remained one of the most dangerous industries in which to be employed. It was also reported that incidence rates for industrial injuries and illnesses in 1983, 1984, and 1985 were highest in the construction industry (NSC, 1986).

Washington State Department of Labor and Industries (L & I) statistics supported the nation-wide trend of lower occupational death rates in construction from 1981 through 1985, as well as a decreased number of fatalities during that same period (DLI/DISH, 1985). However the L & I statistics also noted a decrease in the size of the construction work force within the state and a corresponding decrease in the number of injury accidents from 1979 to 1983 (DLI/IID, 1985).

In Great Britain, worker safety within the construction industry also appears to be a serious concern. In 1983 more occupational fatalities occurred in the construction industry (116) than in any other industry. It was further noted that construction workers exhibited the highest injury incidence rate as well as the highest fatality rate for all industrial workers within the United Kingdom (Civil Engineering, 1985).

It is apparent from the literature that a wealth of information exists supporting the fact that the construction industry is one of the most dangerous industries in which to work, and yet this information is often too generalized or vague and is seldom presented in a meaningful manner (NSC, 1986). It is this information, however, that forms the basis for conducting essential construction safety research. While the detailed study of accident phenomena is required to promulgate meaningful safety standards, this does not guarantee the successful implementation of those standards.

The National Institute for Occupational Safety and Health (NIOSH) was created under the Occupational Safety and Health Act, and assigned responsibility for conducting and coordinating research efforts within the construction workplace (Dept. of Labor, 1971). Despite the continuing efforts of NIOSH and other agencies to mitigate the effects of construction accidents, occupational injuries remain a significant factor in the construction workplace.

It is generally assumed that excavation work consists of less than 15 percent of the total effort on most projects, yet this phase of construction has been the subject of much scrutiny (McGraw-Hill, 1976; Means, 1986). A recent NIOSH report revealed that for the period 1976 to 1981 excavation work annually accounted for about 1,000 work-related injuries. It is estimated that each year 75 of the excavation-related injuries result in fatalities, representing about 1 percent of all occupational fatalities that occur annually within the United States (NIOSH, 1985).

Under the Fatal Accident Circumstances and Epidemiology Project, NIOSH performed detailed case studies on the circumstances surrounding four of the excavation-related fatalities. It was discovered that established OSHA safety standards regarding excavation were not observed, and adherence to these standards could have prevented all of these accidents. NIOSH cited two primary reasons for this lack of adherence to OSHA standards; contractors were unaware of the standards, and requirements within the standards were misinterpreted (NIOSH, 1985). While this study was confined to excavation cave-ins, it addressed an issue of importance to the entire construction industry, namely adherence to established safety standards.

The underlying reasons for the disregard of safety standards remain unclear in the absence of further study; however, if safety standards are to be successfully implemented in the construction workplace, the reasons why standards are disregarded must be determined and appropriate countermeasures taken.

Further review of construction accident literature revealed the existence of national differences in accident fatality rates, consistent with the notion that demographic considerations might be a factor in the safety records of contractors indigenous to certain countries (NSC, 1986).

A study of accident occurrences by time of day, conducted by Hinze (1981), revealed that first aid accidents occurring on one large construction project did not follow the same distribution as reportable injuries. First aid accidents were characterized by a "classic" distribution with peaks at mid-morning and mid-afternoon and a decline in the number of incidents just before noon and quitting time. Reportable injuries were characterized by a uniform distribution during the morning, and peak accident occurrence during the noon hour when first aid accidents were reported to be a minimum. The distribution of reportable injuries in the afternoon was characterized by a steady decline in the number of incidents.

It is assumed that accidents generally follow the same distribution regardless of the severity of the accident, however, results of this study suggested the possibility that different patterns may exist for the distributions of different severities of accidents. Further research was recommended to determine if this phenomenon applied to the entire construction industry (Hinze, 1981). This recommendation for further study exemplifies the fact that, regardless of the focus of individual research efforts, the need persists for specific and detailed research as an essential element in the effort to create a truly safe workplace.

Research Methodology

As previously stated, the purpose of this report is to demonstrate a methodology by which existing injury data can be analyzed to provide meaningful feedback. Accident data used to accomplish this objective was acquired from the Army Corps of Engineers, and included accidents that occurred during the period 1977 to 1987.

3.1 Background

The purpose of this research project at the outset was to attempt to identify some differences between the safety records of United States contractors and foreign contractors based on the assumption that demographic characteristics might influence a contractor's safety practices on the job site. Additionally, it was assumed that accidents that occurred outside the United States could be largely attributed to foreign contractors.

The decision to use Army Corps of Engineers data was based on the fact that it included accidents from contractors originating in many countries. Additionally, this information was accessible to the public under the Freedom of Information Act. The specific procedure by which data was acquired is explained in detail in Appendix A.

Following the initial request for information, a four month delay was experienced before the data was received in a form compatible with University of Washington computer resources. The information was sent on a magnetic tape consisting of eleven files, one for each year. A computer printout accompanied the magnetic tape, and included a legend depicting the information contained within each column of an individual record as well as a legend to some of the Army Corps' data coding schemes.

3.2 Format of the Accident Records

The Army Corps of Engineers maintains its computerized accident data base on a Harris Series 500 computer system. As previously mentioned, each file contains information on accidents recorded in a single year. Each record within a file represents an individual accident report, and consequently the file lengths vary depending on the number of accidents reported within a given year. While the file lengths vary, the individual record lengths are fixed within a given year. It should be noted that the recording system was changed in 1984. A 228 byte record length was used from 1977 to 1983, while a 1956 byte record length began to be used in 1984. Software limitations precluded use of the files with the longer record lengths, and hence this research effort was confined to analyzing data in the 1977 to 1983 time frame.

Each column or group of columns within an individual record corresponds to a section of the Army Corps' Mishap Report, Engineering Form 3394. Included within this accident report are items such as age and sex of the individual involved, time of day of accident occurrence, monetary value of property damage, activity at the time of the mishap, etc. A copy of Engineering Form 3394 is included as Appendix B.

Communication with Army Corps of Engineers personnel indicated that multiple injury accidents result in the filing of more than one mishap report, one for each injured party. General information about the incident (amount of property damage, a narrative, etc.) is only included in the first mishap report, and is referenced in additional reports. It should be noted that no multiple injury accidents were observed in this sample (Humberson, Jan 1988).

3.3 Scope of the Research

Analysis of Army Corps of Engineers' accident data from 1977 through 1983 included an examination of property damages and time of day distributions based on geographic location and severity of the accident. Analyses were also conducted that included accident incidence rates based on region, and the phases of construction in which accidents occurred based on severity of the accident.

It should be noted that in conducting the different analyses of this research effort, the purpose was to examine several items in general terms, rather than to perform a rigorous statistical analysis of a single piece of information or of all available information.

3.4 Structure of the Research

The research was structured to create a profile of Army Corps accidents from a two-tiered perspective. This profile first considered "Corps-wide" accidents, representative of all types of accidents, and then included construction accidents as a subset of "Corps-wide" accidents.

The term "Corps-wide accidents" encompasses any and all reportable accidents involving Army Corps of Engineers personnel, or employees of another agency or firm under contract to the Army Corps of Engineers. According to Army Corps personnel, an accident is also considered "reportable" if it involves a member of the public and the Army Corps of Engineers acting in any capacity (Humberson, Jan 1988).

Included within the Corps-wide portion of the profile were motor vehicle accidents, maritime accidents, aircraft accidents, recreational accidents, fires, incidents involving nuclear

reactors, and construction accidents. The construction portion of the profile was strictly limited to construction-related accidents that occurred on Army Corps of Engineers projects.

Corps-wide accidents were analyzed on the basis of whether they occurred within the continental United States (CONUS) or outside the continental United States (Non-CONUS). Analysis of construction accidents was confined to accidents that occurred within the continental United States.

The individual analyses used to create this two-tiered profile of accidents within the Army Corps of Engineers included the following:

- o Property damage (Corps-wide and Construction).
- o Time of day (Corps-wide and Construction).
- o Corps-wide incidence rates.
- o Phase of Construction.

3.5 Data Extraction

As mentioned previously, the original accident records were stored on a magnetic tape. These records were transferred from magnetic tape to disk storage on a mainframe computer.

Extraction of specific items within the data base was performed through use of a series of computer programs, each designed to extract only the information necessary for the analysis at hand. The fixed nature of the record lengths allowed pertinent columns to be isolated for each analysis using the legend provided by the Army Corps of Engineers (see Appendix C).

Execution of each program concluded with the creation of several new files for each year of accidents analyzed. These new files were then transferred from the mainframe computer to a personal computer using a telecommunications software package.

The telecommunications package transferred the necessary information in the form of a text file. Each text file was then copied onto a spreadsheet, which served as the means by which manipulations on the data were made.

To facilitate manipulation of the data in a spreadsheet it was necessary to limit the size of the mainframe computer output files. The limiting factor in determining the size of the output files was the combined size of the resultant spreadsheet and spreadsheet program relative to the memory capacity of the personal computer used to perform the data manipulations. Arranging the data in a CONUS/Non-CONUS grouping or by severity of the accident produced spreadsheets of a manageable size, less than 290,000 bytes.

Implementation of a CONUS/Non-CONUS grouping required division of the data on the basis of geographic location, as denoted by the Engineering Reporting Organizational Code, or EROC. The EROC is the administrative means by which the Army Corps of Engineers apportions responsibility for different geographic regions. Figure 3.1, a map provided by the Army Corps of Engineers, displays EROC boundaries within the CONUS grouping.

The severity of each accident is represented within the data base as one of nine levels of severity. The defined levels of severity include (in order) no injury, first aid, medical treatment--returned to job, medical treatment--terminated or transferred, lost workdays--returned to job, lost workdays--terminated or transferred, restricted work activity, fatal, or severity unknown.

3.6 Analyses Performed and Parameters Analyzed

Each accident record contained property damage information for up to five parties. A single monetary amount was calculated for each record, and then this was tabulated according to severity of the accident and the year in which it occurred. Intrinsic spreadsheet functions were used to calculate the total property damage, the average property damage per incident, and the standard deviation for each level of severity, by year and grouping (CONUS or Non-CONUS).

FIGURE 3.1. Map of CONUS Engineering Regions (EROCs).

Source: U.S. Army Corps of Engineers

The property damage parameters (total amount, number of incidents, mean, and standard deviation) were totalled by severity of the accident to represent the entire time period, 1977 to 1983. All monetary values were adjusted to reflect 1987 dollars using U.S. Bureau of Labor Statistics Producer Price Indexes for the construction industry (see Appendix D). A representative standard deviation for each level of severity was calculated by weighting the average of the individual annual standard deviations using the number of reported incidents, i.e., the weight of the individual annual standard deviation is directly proportional to the sample size for that year.

A median property damage value and a 90th percentile were also calculated for each grouping (CONUS or Non-CONUS) to facilitate comparison of injury accidents and non-injury accidents.

The time of day information was examined by tabulating the number of incidents that occurred during different hours of the working day, and then generating a histogram for each severity of accident for each group, CONUS or Non-CONUS.

Accident incidence rates, reported as accidents per million man-hours, were calculated for the Corps-wide sample only based on the EROC's.

The phase of construction analysis examined accident occurrences based on the severity of the injury and the phase of construction in which the accident occurred. The Army Corps of Engineers categorized construction accidents by nineteen recognized phases of construction and one "other" phase. A comprehensive list of these phases is presented in conjunction with the results of this analysis.

RESULTS

This chapter presents the results of all analyses performed on data acquired from the Army Corps of Engineers. Presented first will be the results of analyses performed on the entire Army Corps accident data base of which construction-related accidents constitute a subset. This "Corps-wide" analysis will be followed by a presentation of the results of an analysis confined to construction-related accidents.

4.1 Corps-Wide Accident Analysis

Included within Section 4.1 are an analysis of property damages attendant to an accident, an analysis of the times of day accidents have occurred, and a presentation of the accident incidence rates for each administrative region defined by the Army Corps of Engineers.

4.1.1 Property Damage by Severity of the Accident

The primary means of comparison for this property damage analysis includes the median property damage value, the 90th percentile of the sample, and, to a lesser extent, the total property damage and number of reported accidents. The severity of the accident is used to further classify an accident in human terms, ranging from a fatal accident to no injury.

The property damage associated with an accident is reported as the cost to the government for repair or replacement of the damaged property. For example, costs incurred by contractors or subcontractors are not included. Since the reported value is the actual cost to the government, it may reflect a value less than the total property damage sustained in an incident. Consequently, the values presented in this property damage analysis are a conservative representation of the total property damages attendant to an accident. Furthermore, to facilitate meaningful comparisons, the monetary values for all accidents were adjusted to reflect 1987 dollars.

Initial analysis of the Corps-wide data utilized the average property damage per incident and standard deviation as the primary means of comparison. This analysis revealed slight differences between the costs of CONUS accidents and Non-CONUS accidents. These differences are summarized in Tab ≥ 4.1. In the case of injury accidents the average cost per accident fluctuated between the two groupings, CONUS and Non-CONUS. However, the average costs of property damages of non-injury accidents were comparable between the two groupings.

TABLE 4.1. Corps-Wide Property Damage Summary.

	CONUS	Non-CONUS
Injury Accidents		
Total Cost	$ 12,212,599.49	$ 2,385,531.89
Sample Size	11,472	1,287
Average Cost	$ 1,064.56	$ 1,853.56
Standard Deviation	$ 26,651.21	$ 26,281.13
Non-Injury Accidents		
Total Cost	$ 70,478,222.10	$ 19,832,287.78
Sample Size	3,150	912
Average Cost	$ 22,374.04	$ 21,745.93
Standard Deviation	$ 328,825.11	$ 428,345.06

Apparent from Table 4.1 is the existence of large standard deviations. This reveals that the data is not normally distributed, and that further analysis must be conducted to determine the distribution of property damages.

Additional analysis revealed that the median property damage value is zero for CONUS and Non-CONUS injury accidents reported during the period 1977 to 1983. Table 4.2 shows the distribution of property damages for CONUS and Non-CONUS injury accidents. It should be noted that the 90th percentile for CONUS injury accidents is zero dollars, and the 90th percentile for Non-CONUS injury accidents is 550 dollars.

TABLE 4.2. Distribution of Property Damages for Corps-Wide **Injury** Accidents.

Range (in Dollars)	CONUS Injuries	Non-CONUS Injuries
0	10,596	1,125
0 to 500	196	27
500 to 2,500	301	67
2,500 to 5,000	166	35
5,000 to 10,000	91	11
10,000 to 50,000	95	18
50,000 to 100,000	13	2
100,000 to 500,000	11	1
Over 500,000	3	1
Total Injuries	11,472	1,287
Median Value	$ 0	$ 0
90th Percentile	$ 0	$ 550

Table 4.3 shows the distribution of property damages for CONUS and Non-CONUS non-injury accidents. The median property damage value in the CONUS grouping is $1,070, and the 90th percentile is $13,000. The median property damage value in the Non-CONUS grouping is $1,275, and the 90th percentile is $5,050.

TABLE 4.3. Distribution of Property Damages for Corps-Wide **Non-Injury** Accidents.

Range (in Dollars)	CONUS	Non-CONUS
0	214	102
0 to 500	650	188
500 to 2,500	1,367	409
2,500 to 5,000	351	120
5,000 to 10,000	207	42
10,000 to 50,000	227	40
50,000 to 100,000	52	4
100,000 to 500,000	43	6
Over 500,000	9	1
Total Injuries	3,120	912
Median Value	$1,070	$1,275
90th Percentile	$13,000	$5,050

The Corps-wide property damage analysis also revealed that the percentage of injury accidents versus non-injury accidents was significantly higher <u>inside</u> the continental United States than it was <u>outside</u> the continental United States. Table 4.4 shows that 78.5 percent of the accidents in the continental United States were injury cases, while only 58.5 percent of the accidents in the Non-CONUS grouping were injury cases.

TABLE 4.4. Distribution of Accidents and Damages.

Type of Accident	Distribution of **Accidents**	Distribution of **Damages**
CONUS:		
Injury Accidents	78.5 %	14.8 %
Non-Injury Accidents	21.5 %	85.2 %
Non-CONUS:		
Injury Accidents	58.5 %	10.7 %
Non-Injury Accidents	41.5 %	89.3 %

Table 4.4 also reveals that while the distribution of injury accidents and non-injury accidents was significantly different between the CONUS grouping and the Non-CONUS grouping, the distribution of direct costs remained relatively unchanged. Within the continental United States, non-injury accidents accounted for 85.2 percent of the damages sustained while outside the continental United States non-injury accidents accounted for 89.3 percent of the direct costs.

Table 4.5 presents a year-by-year compilation of direct costs for accidents that occurred within the continental United States, including total property damage and number of accidents, subdivided by severity of the injury. Table 4.6 represents the same information for the non-continental United States.

In Table 4.5 and Table 4.6 no coherent trends were observed in the annual fluctuations of property damages, either within the different levels of severity or within the collective categories of injury accidents versus non-injury accidents. This was observed to be the case for both the CONUS grouping as well as the Non-CONUS grouping.

TABLE 4.5. CONUS Corps-Wide Property Damage by Severity.

CONUS	1977	1978	1979	1980	1981	1982	1983		TOTAL
Death								**Death**	
Total $	1,381,420.29	3,097,178.59	143,080.28	116,615.07	141,039.05	1,001,958.82	37,990.76	Amount =	$5,919,282.87
N =	383	362	347	416	342	340	296	N =	2486
Firstaid								**Firstaid**	
Total $	65,975.56	79,840.30	121,783.67	65,905.96	40,907.46	58,058.88	53,268.57	Amount =	$485,740.39
N =	35	20	29	28	27	14	13	N =	166
Lost Days (Return to Work)								**Lost Rtn**	
Total $	309,399.61	1,448,202.87	140,203.60	177,995.79	301,420.93	197,329.82	265,588.75	Amount =	$2,840,141.37
N =	829	908	992	1170	1101	974	862	N =	6836
Lost Days (Terminated)								**Lost Term**	
Total $	.00	107,729.25	26,092.40	962.82	.00	.00	427.86	Amount =	$135,212.33
N =	11	23	18	25	15	16	13	N =	121
Medical (Return to Work)								**Med Rtn**	
Total $	148,375.57	178,057.78	475,974.95	304,509.82	107,788.34	35,193.80	172,246.81	Amount =	$1,422,147.06
N =	219	207	229	260	295	203	131	N =	1544
Medical (Terminated)								**Med Term**	
Total $	4,761.63	20,109.46	1,369.85	.00	47,152.98	3,298.80	.00	Amount =	$76,692.72
N =	4	4	5	3	2	3	0	N =	21
No Injury								**No Injury**	
Total	$30,142,594.01	17,610,624.03	7,670,929.46	3,442,021.47	5,286,357.64	3,228,344.23	3,097,351.28	Amount =	$70,478,222.10
N =	586	513	488	546	420	360	237	N =	3150
Restricted Work								**Restrict**	
Total $	69,123.00	.00	7,827.72	.00	4,490.76	2,639.04	.00	Amount =	$84,080.52
N =	18	9	10	3	5	7	7	N =	59
Unknown								**Unknown**	
Total $	13,126.23	430.92	1,696.01	19,411.57	439,304.11	691,604.42	83,728.99	Amount =	$1,249,302.24
N =	20	4	5	28	78	70	34	N =	239

Total $ for Injury Accidents	$12,212,599.49
Total # of Injury Accidents	11472
Total $ for Non-Injury Acc.	$70,478,222.10
Total # of Non-Injury Acc.	3150

TABLE 4.6. Non-CONUS Corps-Wide Property Damage by Severity.

Non CONUS		1977	1978	1979	1980	1981	1982	1983		TOTAL
Death									**Death**	
	Total $	79.36	101,480.95	1,069.79	.00	92,217.76	18,748.18	68,886.53	Amount =	$282,482.57
	N =	5	8	4	3	12	12	10	N =	54
Firstaid									**First Aid**	
	Total $	11,586.63	2,154.59	5,759.90	11,373.26	20,784.36	50,267.11	4,813.43	Amount =	$106,739.28
	N =	3	3	3	3	14	13	1	N =	40
Lost Days (Return to Work)									**Lost Rtw**	
	Total	$274,731.77	17,516.78	14,855.71	92,725.20	31,891.13	14,294.80	165,494.11	Amount =	$611,509.49
	N =	120	94	128	127	204	171	156	N =	1000
Lost Days (Terminated)									**Lost Term**	
	Total $	.00	.00	.00	.00	20,601.36	879.68	.00	Amount =	$21,481.04
	N =	11	2	0	4	11	11	10	N =	49
Medical (Return to Work)									**Med Rtw**	
	Total $	58,856.92	10,856.24	6,169.55	928,431.43	75,177.57	32,218.28	5,003.82	Amount =	$1,116,713.81
	N =	9	12	10	20	17	11	1	N =	80
Medical (Terminated)									**Med Term**	
	Total $	.00	.00	.00	.00	6,848.41	13,195.20	.00	Amount =	$20,043.61
	N =	0	1	0	0	3	2	0	N =	6
No Injury									**No Injury**	
	Total	$797,139.72	1,083,453.18	236,941.17	2,392,228.28	1,458,377.68	13,292,609.17	571,538.60	Amount =	$19,832,287.78
	N =	55	129	103	207	179	138	101	N =	912
Restricted Work									**Restrict**	
	Total $	.00	.00	.00	.00	.00	.00	.00	Amount =	$.00
	N =	4	1	0	0	0	1	0	N =	6
Unknown									**Unknown**	
	Total $	.00	489.81	.00	605.37	90,696.51	133,871.90	898.51	Amount =	$226,562.10
	N =	3	2	2	2	14	24	5	N =	52

Total $ for Injury Accidents	$2,385,531.89
Total # of Injury Accidents	1287
Total $ for Non-Injury Acc.	$19,832,287.78
Total # of Non-Injury Acc.	912

4.1.2 Time of Day by Severity of the Injury

The time of day each accident occurred was tabulated for the period 1977 through 1983 to generate an hourly distribution of the number of accidents. Communications with Army Corps of Engineers' personnel indicate typical workdays start at 8 a.m. and end at 4:30 p.m. For the purposes of this analysis it was assumed that the hours of 8 a.m. to 5 p.m. constituted a "normal" work shift (Humberson, Jan 1988).

Accidents occurring between the hours of 5 p.m. and 8 a.m. were referred to as "other-than-normal" or "off" hours cases, and were simply tabulated as a unit. It was assumed that different factors may contribute to accident occurrence during "off" hours, and that these accidents warrant further study.

It should be recognized that apportionment of accidents into "normal" and "off" hours work shifts ignores the possibility of flexible work hours, however, communications with Army Corps of Engineers' personnel indicate that the assumed delineation of shift times used in this analysis is reasonable (Humberson, Jan 1988). Regional, seasonal, and task-specific characteristics may have dictated actual shift hours slightly different than those assumed in this analysis.

Despite assurances by Army Corps' personnel that the shift times utilized in this analysis were reasonable, it is not known to what extent variance in the actual shift times influenced the sample. Inclusion of shift start times in the accident data base would be necessary to conclusively determine the influence of this unknown.

While the impact of variance in the shift times is not known conclusively, the hourly distributions of accidents presented in this section tended to follow the "classic" pattern suggested by Hinze (1981) for first aid accidents, exemplified by Figure 4.1, with peaks occurring at mid-morning and mid-afternoon. This figure includes all reported incidents with the exception of the fatality cases and the no injury cases.

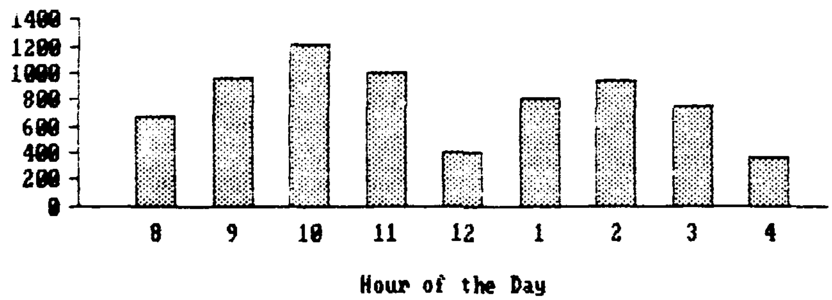

FIGURE 4.1. CONUS Injury Accidents by Hour of the Day, Excluding Fatalities.

In contrast to the "classic" appearance of Figure 4.1 is Figure 4.2, the time of day distribution for CONUS fatalities. It depicts an increase in the number of fatalities with the progression of the work day. It is clear that the time of day distribution for CONUS fatalities is distinctly different from the distribution of less-severe accidents.

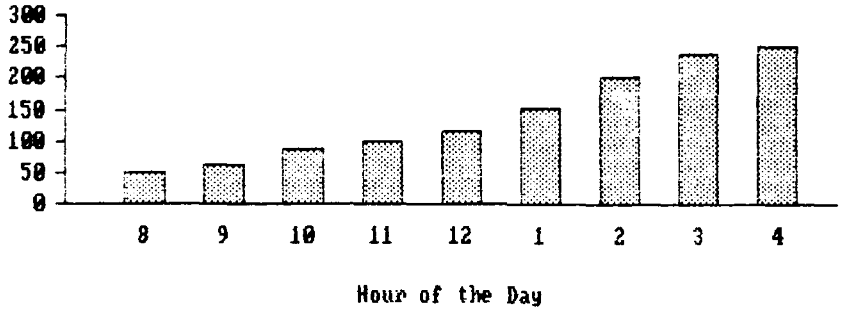

FIGURE 4.2. CONUS Fatal Injuries by Hour of the Day.

Table 4.7 and Table 4.8 display the time of day distributions for each level of severity for all accidents occurring within the Army Corps of Engineers from 1977 through 1983 for which the time of accident occurrence was recorded. Data in a more raw form, from which the figures and tables in this section were derived, are included in Appendix E.

TABLE 4.7. Numerical Distribution of Corps-Wide CONUS Accidents by Time of Day.

Time of Day	Fatal	First Aid	Lost Day (Returned)	Lost Day (Terminated)	Medical (Returned)	Medical (Terminated)	No Injury	Restricted Work	Unknown
8 to 9	49	7	541	11	106	3	189	1	10
9 to 10	59	12	730	13	192	2	191	4	13
10 to 11	86	12	938	18	213	1	231	15	14
11 to 12	96	9	767	14	198	1	232	8	14
12 to 1	116	6	305	4	66	1	166	0	15
1 to 2	151	11	594	9	159	1	219	7	19
2 to 3	200	13	695	14	194	3	252	11	11
3 to 4	240	11	576	8	136	2	242	4	17
4 to 5	254	11	279	2	55	0	189	2	11
Off Hours	1049	53	1148	22	181	5	954	3	56
Total	2300	145	6573	115	1500	19	2865	55	180

TABLE 4.8. Numerical Distribution of Corps-Wide Non-CONUS Accidents by Time of Day.

Time of Day	Fatal	First Aid	Lost Day (Returned)	Lost Day (Terminated)	Medical (Returned)	Medical (Terminated)	No Injury	Restricted Work	Unknown
8 to 9	2	2	95	4	5	0	47	1	1
9 to 10	2	4	94	2	12	1	78	0	1
10 to 11	3	6	112	4	7	0	79	0	7
11 to 12	4	2	80	5	6	1	67	2	3
12 to 1	2	2	25	2	2	1	41	0	2
1 to 2	1	1	83	4	5	1	52	0	3
2 to 3	6	2	101	1	9	0	65	1	0
3 to 4	6	2	114	2	11	1	76	0	2
4 to 5	4	2	99	3	6	1	71	1	6
Off Hours	18	19	235	11	23	2	339	2	15
Total	48	42	1038	38	86	8	915	7	40

Note that 45.6 percent of the CONUS fatalities occurred during "off" hours and that 37.5 percent of the Non-CONUS fatalities occurred during the same period. It cannot be ascertained from the data whether this is a reflection of the exposure during "off" hours or if this indicates a high fatality incidence during "off" hours. However, it is suspected that the

incidence rate is disproportionately higher than the actual exposure. Further study is warranted to establish more conclusive findings.

Figure 4.3 and Figure 4.4 depict the percentage of accidents that occurred during "other-than-normal" work hours. Only those categories of injuries containing a sample of sufficient size to yield reasonable results are represented.

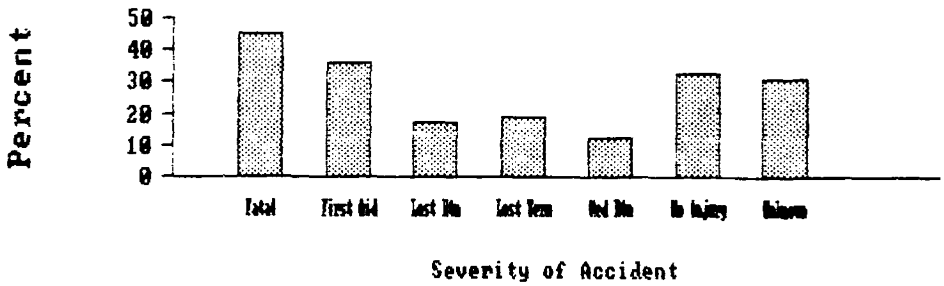

FIGURE 4.3. Percentage of CONUS Accidents Occurring During Other-Than-Normal Work Hours.

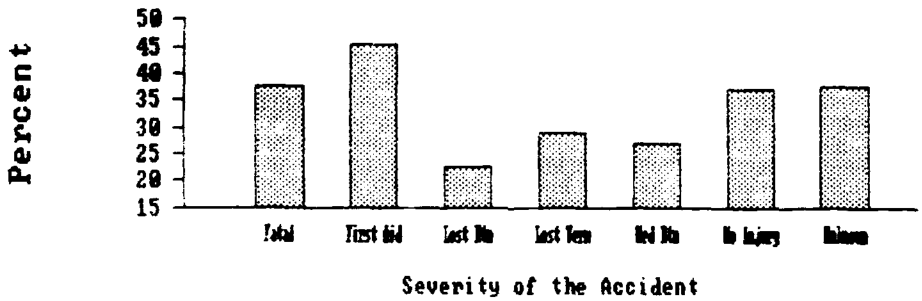

FIGURE 4.4. Percentage of Non-CONUS Accidents Occurring During Other-Than-Normal Work Hours.

4.1.3 Incidence Rates by Administrative Region

Typically viewed as a measure of safety, incidence rates reflect the ratio of accidents in a given region to the number of hours of worker exposure to work-related risks. In this report, this safety indicator is expressed in accidents per million worker-hours of exposure.

For the various regions within the continental United States, the incidence rates for this sample ranged from a low of zero accidents per million worker-hours to a high of 36.53 accidents per million worker-hours over the seven-year period from 1977 through 1983. Outside the continental United States the incidence rates ranged from 0.41 accidents per million worker-hours to 13.64 accidents per million worker-hours over that same period of time. Incidence rates for the individual administrative regions, referred to by their Engineering Reporting Organizational Codes or EROC's, are depicted in Table 4.9.

TABLE 4.9. Incidence Rates by EROC Expressed in Accidents per Million Man-Hours.

EROC	INCIDENCE	EROC	INCIDENCE	EROC	INCIDENCE
CONUS					
Albuquerque Dist.	8.46	Huntsville DIV	1.66	Philadelphia Dist.	21.95
Auto Sup Activity	2.38	Jacksonville Dist.	7.60	Pittsburgh Dist.	30.66
Baltimore Dist.	21.09	Kansas City Dist.	13.85	Portland Dist.	12.59
Board-Rivers/Hbrs	3.57	Little Rock Dist.	18.76	Rock Island Dist.	8.67
Buffalo Dist.	12.70	Los Angeles Dist.	14.87	Sacramento Dist.	9.02
C.E. Research Lab	2.89	Louisville Dist.	14.09	San Francisco Dist.	10.62
Charleston Dist.	4.47	Lower Miss. Vall.	1.22	Savannah Dist.	14.00
Chicago Dist.	12.54	Memphis Dist.	8.05	Seattle Dist.	7.67
Coast Research Ctr	6.99	Missouri River DIV	2.93	South Pacific DIV.	5.37
Cold Regions Lab	3.12	Mobile Dist.	13.72	Southwest DIV.	4.12
Detroit Dist.	11.32	Nashville Dist.	28.29	St. Louis Dist.	8.72
En Act Cap Area	N/A - 12	New England DIV.	16.10	St. Paul Dist.	7.51
Engr Studies Ctr	0	New Orleans Dist.	10.26	Topographic Lab	1.23
Fac Support Agency	1.65	New York Dist.	10.27	Tulsa Dist.	19.60
Ft. Worth Dist.	13.20	Norfolk Dist.	7.75	Vicksburg Dist.	11.20
Galveston Dist.	6.18	North Atlantic DIV	36.53	Walla Walla Dist.	16.60
Hq USACE	.81	North Central DIV.	0	Water Resources	3.33
Humphreys Ctr	N/A - 0	Ohio River DIV.	4.14	Waterways Exp Sta	2.56
Hunnington Dist.	22.54	Omaha Dist.	8.79	Wilmington Dist.	11.22
Non-CONUS					
Al Batin, S.A. Dis	1.80	Jiddah, S.A. Dist.	1.87	Pacific Ocean DIV	4.90
Alaska Dist.	13.05	Mid East DIV (Rear	2.58	Riyadh, S.A. Dist.	.82
European DIV	1.05	Middle East DIV	7.44	Sinai Sup Team	13.64
Far East Dist.	.41	Near East Proj Off	4.70	South Atlantic DIV	2.03
Japan Dist.	1.22	North Pacific DIV	7.86		

In computing the incidence rates it was observed that many of the worker-hours reported overseas were attributed to American contractors and United States government employees, rather than foreign nationals or foreign contractors. This discovery invalidated the assumption that overseas work, and hence overseas accidents, involved foreigners under contract to the Army Corps of Engineers. This fact, coupled with the wide variability in the incidence rates and the geographic spread of the regions outside the continental United States, led to the decision to

discontinue examining differences in accident trends based on regional characteristics in favor of a more meaningful analysis focused within the confines of the continental United States.

4.2 Construction-Related Accident Analysis

This section presents results of analyses conducted exclusively on accidents termed by the Army Corps of Engineers as "construction-related." Excluded from the analyses in this section are accidents in which the individual involved in the mishap was acting in a capacity not directly related to the Army Corps' construction mission.

Analyses undertaken in this section include an examination of property damages attendant to an accident, the times of day accidents have occurred, and an analysis of accident occurrences by phase of construction. These analyses were restricted solely to accidents occurring within the confines of the continental United States.

4.2.1 Property Damage by Severity of the Accident

As was the case in the Corps-wide property damage analysis, the primary means of analysis included the median property damage value, the 90th percentile of the sample, and, to a lesser extent, the total property damage and number of reported

accidents. Table 4.10 presents the value of property damages associated with construction injury accidents compared with damages sustained in non-injury construction accidents for the continental United States.

TABLE 4.10. CONUS Construction-Related Property Damage Summary.

	Injury Accidents	Non-Injury Accidents
Total Cost	$ 2,759,703.77	$ 5,025,054.28
Sample Size	3,653	403
Average Cost	$ 755.46	$ 12,469.12
Standard Deviation	$ 12,147.15	$ 32,895.12

Apparent from Table 4.10 is the existence of large standard deviations, similar to the Corps-wide property damage analysis. As mentioned previously, this reveals that the data are not normally distributed.

Additional analysis revealed that the median property damage value is zero for CONUS injury accidents, and that the median property damage value for CONUS non-injury accidents is $4800. Table 4.11 shows the distribution of property damages for CONUS injury and non-injury accidents. It should be noted that the 90th percentile for CONUS injury accidents is zero dollars, and the 90th percentile for CONUS non-injury accidents is $37,000.

TABLE 4.11. Distribution of Property Damages for CONUS Construction Accidents.

Range (in Dollars)	Injury Accidents	Non-Injury Accidents
0	3,515	21
0 to 500	30	24
500 to 2,500	32	126
2,500 to 5,000	20	60
5,000 to 10,000	18	79
10,000 to 50,000	33	87
50,000 to 100,000	3	1
100,000 to 500,000	2	5
Over 500,000	0	0
Total Injuries	3,653	403
Median Value	$ 0	$ 4,800
90th Percentile	$ 0	$ 37,000

Table 4.12 shows that over 90 percent of all construction-related accidents reported within the continental United States resulted in injuries, and account for 35.4 percent of the total property damages. Non-injury accidents account for 9.9 percent of the incidents reported and 64.6 percent of the total damages.

TABLE 4.12. Distribution of Construction-Related Accidents and Property Damages.

Type of Accident	Distribution of **Accidents**	Distribution of **Damages**
Injury	90.1 %	35.4 %
Non-Injury	9.9 %	64.6 %

Year-by-year compilations of total property damage and number of accidents, subdivided by severity of the injury are presented in Table 4.13 for the CONUS grouping.

TABLE 4.13. CONUS Construction Property Damage by Severity.

CONUS	1977	1978	1979	1980	1981	1982	1983		TOTAL
Death								**Death**	
Total	2380.82	107729.25	97194.19	0	0	43984	0	Amount =	$251,288.26
N =	4	7	9	5	4	5	9	N =	43
First Aid								**First Aid**	
Total	14284.89	58748.35	88061.85	30681.34	0	7807.16	42786	Amount =	$242,369.59
N =	3	5	3	6	1	1	1	N =	20
Lost Rtn								**Lost Rtn**	
Total	203440.64	718324.28	75002.60	58311.75	201952.85	91689.05	210742.44	Amount =	$1,559,463.60
N =	436	438	477	558	608	441	346	N =	3304
Lost Term								**Lost Term**	
Total	0	0	26092.40	962.82	0	0	427.86	Amount =	$27,483.08
N =	9	17	15	20	10	13	12	N =	96
Med Rtn								**Med Rtn**	
Total	31902.92	60184.74	75667.96	193164.96	13472.28	8584.58	103756.05	Amount =	$486,733.49
N =	20	16	19	32	16	18	12	N =	133
Med Term								**Med Term**	
Total	0	12927.51	0	0	47152.98	0	0	Amount =	$60,080.49
N =	1	1	1	1	2	1	0	N =	7
No Injury								**No Injury**	
Total	953171.98	765854.42	810338.62	713204.75	535760.02	660955.27	585769.22	Amount =	$5,025,054.28
N =	48	51	53	85	69	55	42	N =	403
Restrict								**Restrict**	
Total	69123.00	0	0	0	4490.76	2639.04	0	Amount =	$76,252.80
N =	6	3	2	0	1	2	2	N =	16
Unknown								**Unknown**	
Total	0	0	652.31	0	9239.74	4398.40	41742.02	Amount =	$56,032.47
N =	0	0	1	3	12	13	5	N =	34

Total $ for Injury Accidents	$2,759,703.77
Total # of Injury Accidents	3653
Total $ for Non-Injury Acc.	$5,025,054.28
Total # of Non-Injury Acc.	403

4.2.2 Time of Day Analysis -- Construction-Related Accidents

The time of day that each construction-related accident occurred in the continental United States from 1977 to 1983 was tabulated. Similar to the Corps-wide time of day analysis, accidents that occurred during "normal" work hours were accumulated on an hourly basis, whereas all accidents that occurred during "other-than-normal" work hours were tabulated as a unit (Humberson, Jan 1988).

The data was accumulated by severity of the accident; however, small sample sizes in several of these categories necessitated consideration of the data in more general categories, injury or no injury. Preponderant among injury accidents were the lost days cases as can be observed from Figure 4.5.

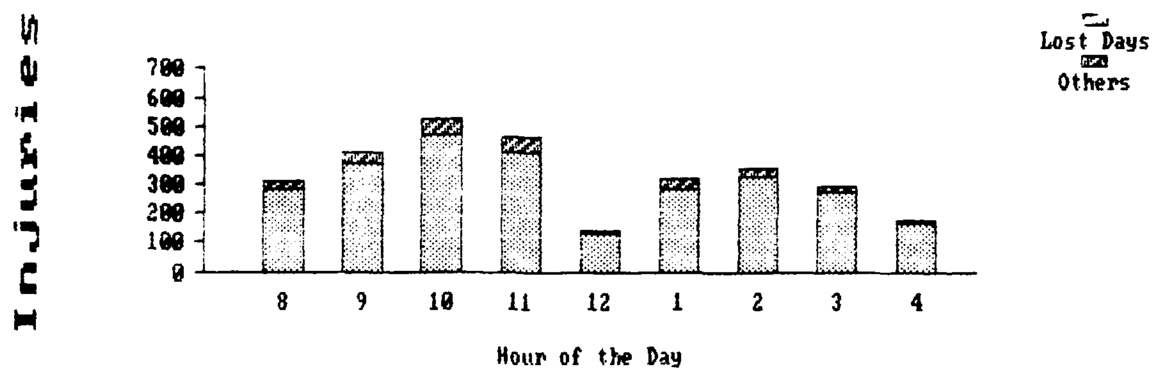

FIGURE 4.5. CONUS Construction-Related Injury Accidents by Hour of the Day.

Construction-related injury accidents, in a fashion similar to Corps-wide injury accidents, tended to follow the "classic" accident frequency distribution (Hinze, 1981). Figure 4.6 reveals that construction-related, non-injury accidents generally followed the same distribution as injury accidents, exhibiting peaks at mid-morning and mid-afternoon. Appearances suggest, however, that a gap may exist in the mid-afternoon data contributing to a certain degree of incongruity.

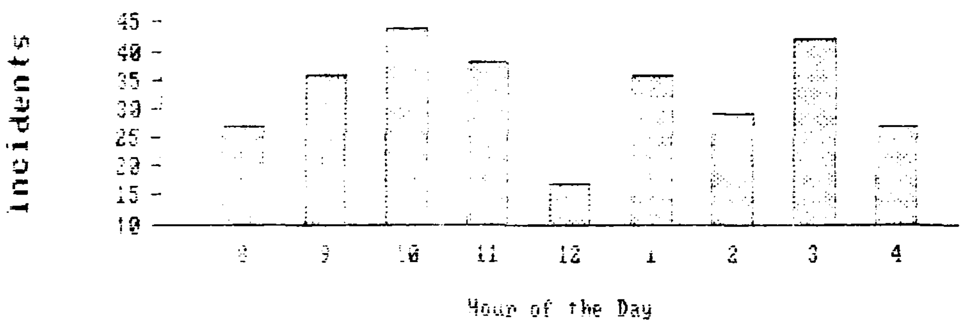

FIGURE 4.6. CONUS Construction-Related Non-Injury Accidents by Hour of the Day.

Analysis of the accidents that occurred during the hours between 5 p.m. and 8 a.m., termed "other-than-normal" work hours or "off" hours, revealed that within the continental United States 30 percent of construction-related fatalities and 26 percent of non-injury accidents occurred during these hours. Figure 4.7 displays the percentage of accidents that occurred during non-typical work hours. Only those severity categories

containing a sample of sufficient size to yield reasonable results are presented.

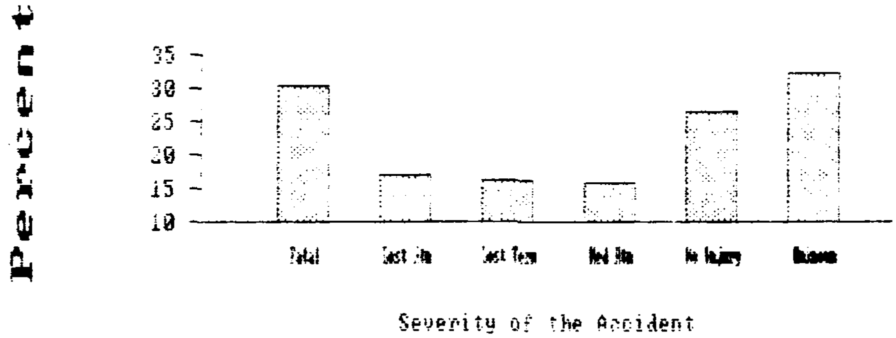

FIGURE 4.7. Percentage of Construction-Related Accidents Occurring During Other-Than-Normal Work Hours.

4.2.3 Analysis of Construction-Related Accidents by Severity and Phase of Construction

The accident data acquired from the Army Corps of Engineers included information regarding the phase of construction during which the accident occurred. The Army Corps distinguished between nineteen distinct phases of construction and one phase labelled "other", all of which are listed in Table 4.14.

Apparent from Table 4.14 is the concentration of accidents within certain phases of construction. Most notable among these phases are excavation and earthwork, forming, concrete placement, and mechanical work.

TABLE 4.14. CONUS Accidents by Phase of Construction and Severity of the Injury.

PHASE	DEATH	FIRST AID	LOST DAY	LOST TERM	MED RTN	MED TERM	ABSTRACT	UNKNOWN	NO INJURY	TOTAL INJURIES
Unknown	[illegible]	0	[illegible]	[illegible]	[illegible]	0	1	[illegible]	[illegible]	[illegible]
Mobilization	3	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Site Prep	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Excav & Earth	17	9	573	10	25	5	2	7	191	646
Foundation	0	0	[illegible]	1	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
Forming	[illegible]	[illegible]	[illegible]	12	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
Framing	[illegible]	[illegible]	[illegible]	1	1	[illegible]	0	[illegible]	1	[illegible]
Concr. Placmnt	1	[illegible]	[illegible]	[illegible]	14	1	[illegible]	4	[illegible]	[illegible]
Steel Erect.	3	[illegible]	[illegible]	5	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Scaffolding	[illegible]	[illegible]	[illegible]	4	[illegible]	0	0	0	[illegible]	[illegible]
Roofing	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	4	[illegible]
Carpentry ext	[illegible]	0	[illegible]	1	[illegible]	[illegible]	1	0	[illegible]	[illegible]
Carpentry int	[illegible]	0	[illegible]	[illegible]	[illegible]	0	0	[illegible]	[illegible]	73
Trim exterior	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1	26
Trim interior	[illegible]	[illegible]	[illegible]	1	0	[illegible]	[illegible]	1	0	39
Utilities	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	0	[illegible]	[illegible]
Mechanical	1	1	[illegible]	[illegible]	[illegible]	[illegible]	1	1	[illegible]	255
Tunneling	1	[illegible]	[illegible]	0	[illegible]	0	[illegible]	0	[illegible]	[illegible]
Demolition	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Warehousing	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Other	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Excavation and earthwork accounted for 17.7 percent of all construction accidents reported on Army Corps projects within the continental United States from 1977 to 1983. Of the accidents reported to have occurred during excavation and earthwork operations, 89.9 percent were classified as "lost day" cases, and 2.6 percent of the accidents were fatalities.

Although no incidence rates were available to allow direct comparison of the different phases of construction, it appears noteworthy that 39.5 percent of all fatalities occurred during

excavation and earthwork operations. Additionally, 47.4 percent of the non-injury accidents occurred during this phase as well.

Nine of the phases of construction collectively account for 81.7 percent of all reported construction injuries, 84.2 percent of all construction accidents resulting in lost work days, and 83.7 percent of all construction fatalities. These phases, each with a sample size in excess of 100 accidents, are presented in Table 4.15.

It should be noted from Table 4.15 that steel erection and excavation exhibited percentages of fatalities (expressed as a percentage of injuries within that phase) higher than the percentage of fatalities for the entire sample, 1.7 percent and 2.6 percent respectively.

TABLE 4.15. Percentage of Lost Day Cases and Fatalities by Phase of Construction.

Phase	Total Injuries	Lost Days as a % of Injuries in That Phase	Fatalities as a % of Injuries in That Phase	Fatalities as a % of all Fatalities
Site Prep.	191	95.3 %	0.0 %	0.0 %
Excav. & Earth.	648	89.9 %	2.6 %	39.5 %
Forming	428	94.4 %	1.2 %	11.6 %
Concr. Plcmnt.	309	92.9 %	0.3 %	2.3 %
Steel Erection	181	95.6 %	1.7 %	7.0 %
Carpentry, ext.	109	94.5 %	0.0 %	0.0 %
Utilities	107	98.1 %	0.9 %	2.3 %
Mechanical	255	96.9 %	0.4 %	2.3 %
Other	756	92.2 %	1.1 %	18.6 %
Percent of Entire Sample	81.7 %	84.2 %	1.2 %	83.7 %

Conclusions and Recommendations

The results presented in this report are intended to generate interest in the further study and promotion of safety in the construction workplace. This chapter endeavors to interpret the results of this research effort, and provide insights into topics and methods for future analyses.

5.1 Corps-Wide Property Damage Analysis.

The Corps-wide property damage analysis was presented in Section 4.1.1. and represents a calculation of direct property damages attendant to accident occurrences within the Army Corps of Engineers from 1977 through 1983. As previously mentioned, the property damages reported reflect the actual cost to the government for repair or replacement of the damaged property, and do not include costs incurred by parties under contract to the government. It was expected that these property damages would be higher for accidents that occurred outside the continental United States, primarily due to additional expenses incurred in shipping and resupply, or to full replacement of equipment damaged abroad in lieu of repair.

It was discovered that the average value of property damaged in an injury accident within the continental United States was 1,065 dollars, and the standard deviation for this

sample of accidents was 26,651 dollars. The average property damage for Non-CONUS injury accidents was 1,854 dollars, and the standard deviation was 26,281.13 dollars. However, the large standard deviations peculiar to this property damage analysis indicate that the data is not normally distributed.

Further analysis revealed that the median property damage value for CONUS and Non-CONUS injury accidents was zero dollars. Additionally, 90 percent of the injury accidents that occurred outside the continental United States reported less than $550 in property damages, while the 90th percentile for CONUS injury accidents was zero dollars.

The Corps-wide analysis of property damages attendant to non-injury accidents also revealed the existence of high tandard deviations. While the CONUS grouping exhibited a standard deviation of 328,825.11 dollars, the standard deviation for the Non-CONUS grouping was nearly 100,000 dollars higher.

Additional analysis revealed that the median property damage value for CONUS non-injury accidents was $1,070 and the 90th percentile was $13,000. The median property damage value for non-injury accidents that occurred outside the continental United States was $1,275 and the 90th percentile was $5,050.

It is unclear whether differences between the two groupings are a reflection of actual cost differences, disparity in the sample sizes, or that different distributions characterize each grouping. Statistical analyses of a more rigorous nature would be required to establish more conclusive findings.

Annual fluctuations within the different severity categories were noted, however, no discernible pattern was observed. It should be further noted that there appeared to be no coherent trend in the relationship between severity of the injury and property damages. However, accidents resulting in lost work days typically reported the least amount of property damage per incident, while non-injury accidents resulted in the highest cost per incident. It is not known whether this phenomenon can be attributed to inherent characteristics of these accident severities, or if it is the result of statistical factors such as variance within a grouping or differences in sample size.

5.2 Construction-Related Property Damage Analysis.

As was the case in the Corps-wide property damage analysis, the data was characterized by large standard deviations. Analysis of CONUS injury accidents revealed that the median property damage value and the 90th percentile were both zero.

The median value for property damages attendant to CONUS non-injury accidents was $4,800. The 90th percentile was $37,000.

Further analysis might reveal more accurately a characteristic property damage distribution, such as a log normal distribution.

5.3 Corps-Wide Time of Day Analysis.

Based on communications with several Army Corps of Engineers personnel, a "normal" work shift was assumed to occur between the hours of 8 a.m. and 5 p.m.. Data taken from the Corps-wide sample revealed that injury accidents and non-injury accidents followed the "classic" time of day distribution suggested by Hinze (1981) for first aid accidents. This "classic" pattern was characterized by peak accident occurrence during mid-morning and mid-afternoon, with noticeable decreases in accidents prior to lunch time and quitting time.

Corps-wide fatal accidents that occurred within the continental United States constituted the only significant departure from the "classic" time of day distribution. CONUS fatalities reflected a trend in which the number of accidents that occurred during an hour increased as the day progressed. This phenomenon might be legitimized through the argument that

fatigue becomes a greater factor as the day progresses. However, one cannot conclude that fatigue accounts for this departure from the norm without first examining the nature of the accidents, and the task being performed at the time of the fatality. It is clear that the distribution of Corps-wide fatalities differs significantly from the distributions of less-severe accidents, and that detailed analysis of the circumstances surrounding fatal accidents is required to account for the distribution of fatal accidents throughout the work day.

It was further noted in the "off" hours analysis, that a higher percentage of fatal accidents occurred during these "other-than-normal" work hours in comparison to other severities of accidents. CONUS fatalities that occurred during "off" hours composed 45.6 percent of all fatal accidents, while this percentage decreased to 37.5 percent outside the continental United States. It could not be ascertained from the data whether the high percentage of fatalities that occurred during "off" hours was a reflection of the exposure or if this indicated a high fatality incidence. However, it is suspected that the incidence rate is disproportionately higher than the actual exposure.

Furthermore, it remains unclear whether "off" hours implies shift work, overtime, or a certain percentage of each. A preponderance of shift work could lead to the conclusion that factors other than fatigue contribute to the higher percentage of

fatalities during "off" hours, whereas, overtime might indicate fatigue as the primary factor. The intensity and type of work performed are other factors that should be considered in an analysis of accidents that occurred during "off" hours. While the implications of this information remain unclear, further study is warranted to establish more conclusive findings.

5.4 Construction-Related Time of Day Analysis.

Construction-related accidents also followed the "classic" time of day distribution when considered in injury and non-injury groupings, rather than by individual severity categories. Detailed analysis of the time of day distributions for individual severity categories was hindered by a small sample size. It should be noted, however, that accidents resulting in lost work days clearly followed the "classic" pattern, and were preponderant among this sample.

Analysis of "other-than-normal" work hours cases produced results similar to the Corps-wide analysis, which has already been discussed.

5.5 Accident Incidence Rates by Region.

Incidence rates were derived from the accident records and man-hour listings provided by the Army Corps of Engineers, and were presented as accidents per million man-hours ordered by

region. In combining these two data bases it was observed that much of the work done in certain regions outside the continental United States was performed by US contractors, rather than contractors indigenous to the region. It had been previously assumed that projects undertaken in a foreign country would be performed by contractors indigenous to that country. While this assumption was completely valid for European construction projects, it was not valid in Saudi Arabia or the Far East.

A combination of factors confounded analysis of accident incidence rates in the context of a CONUS/Non-CONUS grouping. Wide variability in the incidence rates was noted and suggested that these groupings may not exhibit a sufficient degree of homogeneity to warrant representation of further analyses utilizing a CONUS/Non-CONUS grouping. Furthermore, while it is presumed that demographic characterisitics may contribute to accident occurrence, a CONUS/Non-CONUS grouping ignores this presumption both within the continental United States as well as outside the continental United States. Ultimately, the revelation that United States contractors performed a significant amount of construction outside the continental United States led to the conclusion that a CONUS/Non-CONUS grouping would not accurately reflect differences between United States and foreign contractors.

Accurate assessment of the differences between United States contractors and "foreign" contractors, requires analyzing these contractors based on demographic characteristics rather than just geographic region.

5.6 Analysis of Accidents by Phase of Construction and Severity.

Analysis of construction-related accidents based on the phase of construction in which these accidents occurred, revealed that excavation and earthwork operations account for more reported accidents than any other single phase. These operations account for 17.7 percent of all reported accidents and 39.5 percent of all construction fatalities that occurred on Army Corps of Engineers projects. It should be further noted that excavation and earthwork operations accounted for 46.5 percent of construction-related non-injury accidents.

Despite the fact that exposure rates for each phase of construction could not be extracted from the available data, it appears that general conclusions can still be made. As stated previously, it is generally assumed that excavation work consists of less than 15 percent of the total effort on most projects (McGraw- Hill, 1976; Means, 1986). Thus, the number of fatalities appears to be disproportionately high during the excavation and earthwork phase of construction. However, in the

absence of further analysis one can only hypothesize the existence of some causal relationship accountable for the preponderance of accidents within excavation and earthwork operations.

Other phases of construction, considered individually and collectively, accounted for a significant portion of the accident data. These phases include site preparation, forming, concrete placement, steel erection, exterior carpentry, utilities, mechanical work, and "other" non-specified phases. Collectively, these phases represent a broad range of construction tasks, and account for 81.7 percent of all reported accidents and 83.7 percent of all construction-related fatalities.

The data further revealed that 2.6 percent of the injury accidents that occurred **within** excavation and earthwork operations resulted in fatalities. This percentage of fatalities within the excavation and earthwork phase appears to be significantly higher than the 1.2 percent fatalities (expressed as a percentage of the number of injuries) reflective of the entire sample. The steel erection phase of construction also reported a high percentage of fatalities relative to the number of injuries (1.7 percent). It is assumed that the high percentage of fatalities within these phases can be attributed to factors unique to each phase.

It is unclear whether differences between the phases of construction can be attributed to inherent dangers within these phases or if these differences are a function of exposure. It is also possible that the sample size may have had an impact on the analysis.

Evident from this analysis is the need for future investigaton into the peculiarities of operations within the different phases of construction. While this report simply provides a cursory analysis of accidents by phase of severity, there appears to be a distinct need for heightened safety consciousness within these phases of construction and within the industry as a whole.

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Hinze, J. 1981. Biorythm Cycles and Injury Occurrences. <u>Journal of the Construction Division ASCE</u>. Vol. 107, CO1.

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U.S. Department of Labor, Occupational Safety and Health Administration. 29 CFR Part 1910. "Safety and Health Regulations for Construction." Federal Register. Vol. 36, No. 75. April 17, 1971.

APPENDIX A

Data Acquisition Procedure

Accident data can be acquired from the Army Corps of Engineers by contacting the following agency:

Chief, Occupational Safety and Health Division
Directorate of Engineering and Construction
U.S. Army Corps of Engineers
Washington, D.C.
20314-1000

Phone: (202) 272-0094

Certain information is required to facilitate acquisition of the data. For example, it was necessary to specify how the data was to be used (to avoid any conflict with the Privacy Act), the type of information desired (e.g. construction accidents from 1977 through 1983), and also the format of the data (printout, diskette, or magnetic tape). Additional information was required regarding the format of the magnetic tape, and included the following items:

- o Type of receiving computer (Vax 3)
- o Tape Density = 1600 BPI
- o Files Unlabeled
- o Recorded in ASCII

APPENDIX B

Sample U.S. Army Corps of Engineers Mishap Report (ENG FORM 3394)

MISHAP REPORT (OCE Suppl 1 to AR 385-40)	REPORT SUBMISSION (cc 01)	FILE IDENTITY (cc 02-12)					REQUIREMENTS CONTROL SYMBOL (DAEN SO-8(R1))
	1. ☒ BASIC 2. ☐ SUPPLEMENTAL 3. ☐ CORRECTION	FOA	YR	MO	PT. NO	INJ NO	
	1	G 3	8 Ø	1 2	Ø 2 4	Ø Ø	

SECTION A – PERSON INVOLVED

1. NAME (ALL CAPS - Last, First, Middle) (cc 13-48) NAME DELETED	2. AGE (cc 49-50) (Nearest Year)	3. SEX (cc 51) 1. ☒ MALE 2. ☐ FEMALE — 1
North Pacific Division Seattle District, Seattle, Washington	4. ASSIGNMENT (Gov't Employees Only) (Coded by FOA) (cc 52-55) Ø 4 Ø 8	

5. CLASSIFICATION (Check appropriate box) (cc 56) 1. ☐ ACTIVE ARMY 2. ☒ GOV'T EMPLOYEE 3. ☐ CONTRACTOR EMPLOYEE 4. ☐ EMPLOYEE OF FOREIGN GOV'T 5. ☐ OTHER, PRIVATELY EMPLOYED 6. ☐ MEMBER OF PUBLIC 2	6. DUTY STATUS (cc 57) 1. ☒ ON DUTY ON POST 2. ☐ ON DUTY OFF POST 3. ☐ OFF DUTY ON POST 4. ☐ OFF DUTY OFF POST 1
7. MILITARY OR CIVILIAN GRADE (cc 58-61) (Coded by FOA) WG-7 W G Ø 7	8. OCCUPATION (cc 62-65) (Coded by FOA) Maintenance Worker Ø Ø 9 9
9. LENGTH OF TIME ON DUTY (Enter nearest hour) (cc 66-67) 5 hours Ø 5	10. TRAINING COMPLETED (cc 68-69) (Coded by FOA) 1 9
11. SUPERVISION OF PERSON INVOLVED (cc 70) (Check appropriate box) 1. ☐ SUPERVISED 2. ☒ NOT SUPERVISED 2	12. SUPERVISION OF THE SITE (cc 71) (Check appropriate box) 1. ☒ SUPERVISED BY CORPS OF ENGINEERS 2. ☐ NOT SUPERVISED BY CORPS OF ENGINEERS 1

13. ACTIVITY AT TIME OF MISHAP (cc 72-76) (Coded by FOA) Driving from Office to next work site on Project Ø 3 Ø 9 Ø	BLANK (cc 77-79)	CARD NO. (cc 80) 1

14. NARRATIVE DESCRIPTION OF MISHAP (Give a word picture explaining the who, what, when and where of the mishap. Include descriptions of equipment, condition, site, weather, and other factors which may have contributed in any way. Use additional blank pages if necessary. Do not continue this description in the remarks section.)

NAME (in Govt Vehicle, '79 Ford Courier PU, Lic #) was making Left turn from Powerhouse Road onto Warland Road (@West end of David Thompson Bridge). He did not see NAME (private '78 Ford 4-Door Sedan, MT Lic #)who was on the bridge, preparing to turn Right onto Powerhouse Road. NAME failed to yeild (as perscribed by posted "Yield" traffic sign) and struck NAME Vehicle on Left front with the Left Front of Govt Vehicle. No bodily injury was incurred by Messrs. NAME, NAME and NAME, (passenger in NAME Vehicle). Mr. NAME is Pwrhse Elec. and Mr. NAME Pwrhse Utilityman. (See remarks)

CORRECTION ACTION BY IMMEDIATE SUPERVISOR Investigate measures to improve visibility and possible change of traffic control signs at intersection. Motor vehicle operation to be covered in safety training.

ENG FORM 3394 1 JAN 78 EDITION OF 1 NOV 74 IS OBSOLETE Page 1 of 4

Source: U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers ENG FORM 3394 page 2.

REPORT SUBMISSION (cc 01)
1. ☒ BASIC
2. ☐ SUPPLEMENTAL
3. ☐ CORRECTION

FILE IDENTITY (cc 02-12)

	FOA		YR		MO		REPT NO			INJ NO
1	G	3	8	Ø	1	2	Ø	2	4	Ø	Ø

SECTION B – THE MISHAP

16. DATE AND TIME (cc 13-22)

MO		DA		YR		HR (24 hr. clock)			
1	2	2	3	8	0	1	2	2	5

17. EXACT LOCATION OF MISHAP Libby Dam. Warland & Powhouse Road

18. STATE OR COUNTY (cc 23-24) (Coded by FOA) Libby, LINCOLN County, Montana 3 Ø

19. WEATHER (Check appropriate box) (cc 25)
1. ☐ RAIN
2. ☐ SNOW
3. ☐ FLOOD (NOT RAIN)
4. ☐ FOG
5. ☐ ICE OR SLEET
6. ☐ TYPHOON, HURRICANE, ETC.
7. ☐ WIND
8. ☐ OTHER ADVERSE WEATHER
9. ☒ WEATHER NOT A FACTOR

9

19A. TYPE OF MISHAP (Check appropriate box) (cc 26)
1. ☐ AIRCRAFT
2. ☐ MARINE (other than recreation)
3. ☐ NUCLEAR REACTOR
4. ☐ RECREATION
5. ☐ CONSTRUCTION
6. ☒ MOTOR VEHICLE, GOV'T
7. ☐ MOTOR VEHICLE, PRIVATELY OWNED
8. ☐ FIRE
9. ☐ OTHER (Specify)

6

19B. PHASE OF CONSTRUCTION (Check appropriate box) (cc 27-28)
1. ☐ MOBILIZATION
2. ☐ SITE PREPARATION
3. ☐ EXCAVATION AND EARTHWORK
4. ☐ FOUNDATION
5. ☐ FORMING
6. ☐ FRAMING
7. ☐ CONCRETE PLACEMENT
8. ☐ STEEL ERECTION
9. ☐ SCAFFOLDING
10. ☐ ROOFING
11. ☐ CARPENTRY, EXTERIOR
12. ☐ CARPENTRY, INTERIOR
13. ☐ TRIM, EXTERIOR
14. ☐ TRIM, INTERIOR
15. ☐ UTILITIES
16. ☐ MECHANICAL
17. ☐ TUNNELING
18. ☐ DEMOLITION
19. ☐ WAREHOUSING
20. ☐ OTHER

20. MOTOR VEHICLE UTILIZATION (Check appropriate box) (cc 29)
1. ☐ REAL ESTATE ACTIVITIES
2. ☐ GOING TO JOB SITE
3. ☒ ROUTING JOB TRANSPORTATION
4. ☐ SPECIAL INVESTIGATION OR TRIP
5. ☐ RETURNING FROM JOB SITE

3

SECTION C – PROPERTY DAMAGE

21. IDENTIFY ALL DAMAGED EQUIPMENT OR PROPERTY	OWNERSHIP (1) BY FEDERAL GOV'T (2) BY STATE OR LOCAL GOV'T (3) BY FEDERAL GOV'T CONTR (4) BY PRIVATE INDIVIDUAL OR FIRM (5) OTHER	DESCRIBE THE DAMAGE TO EACH ITEM	ESTIMATE OF TOTAL DAMAGES IN DOLLARS (LABOR & PARTS)
A. 1979 Ford Pickup, ID-CWE99377 Lic#	(cc 30) 1	Damage to Left Front headlight, fender	(cc 31-38) 1000
B 1978 Ford 4Dr Lic # (Mont)	(cc 39) 4	Damage to Left Frnt headlight, fender	(cc 40-47) 200
C.	(cc 48)		(cc 49-56)
D.	(cc 57)		(cc 58-65)
E.	(cc 66)		(cc 67-74)

BLANK (cc 75-79) CARD NO. (cc 80) 2

Source: U.S. Army Corps of Engineers

U.S. Army Corps of Engineers ENG FORM 3394 page 3.

RE[illegible]T SUBMISSION (cc 01)
1. X BASIC
2. ☐ SUPPLEMENTAL
3. ☐ CORRECTION

FILE IDENTITY (cc 02-12)

	FOA		YR		MO		REPT NO			INJ NO
1	G	3	8	Ø	1	2	Ø	2	4	Ø

SECTION D – THE INJURY

22. SEVERITY (Check appropriate box) (cc 13-19)

1. ☐ FIRST AID
2. ☐ NO LOST WORKDAYS, MEDICAL TREATMENT RETURN TO JOB
3. ☐ NO LOST WORKDAYS, MEDICAL TREATMENT TERMINATED OR TRANSFERRED
4. ☐ LOST WORKDAYS, CAN RETURN TO JOB
5. ☐ LOST WORKDAYS, TERMINATED OR TRANSFERRED
6. ☐ RESTRICTED WORK ACTIVITY
7. ☐ FATAL
8. X NO INJURY

DATE OF DEATH: MO / DA / YR

8

23. DAYS LOST AND TIME CHARGED (cc 20-23)

24. NATURE OF INJURY (cc 24-25) (Coded by FOA)

25. LOCATION OF INJURY (cc 26-28) (Coded by FOA)

26. CAUSE OF INJURY (cc 29-30) (Coded by FOA)

SECTION E – CAUSE ANALYSIS

27. MOTOR VEHICLE OWNERSHIP (cc 31) (Coded by FOA) Government — 1

28. M/V MISHAP TYPE (cc 32-33) (Coded by FOA) — 3 1

29. AGENCY OF THE MISHAP (the object most closely associated with the MISHAP) (cc 34-38)
US Army Corps of Engrs — 2 1 Ø 4 3

30. SAFETY REQUIREMENT VIOLATED (cc 39-43) (Coded by FOA) — 1 9 B 1 3

31. CORRECTIVE MEASURES REQUIRED TO PREVENT SIMILAR MISHAPS HAVE BEEN COORDINATED WITH (Check box indicating appropriate staff) (cc 44)

1. ☐ MANAGEMENT
2. X OPERATIONS
3. ☐ MAINTENANCE
4. ☐ PERSONNEL (ASSIGNMENT)
5. ☐ PERSONNEL (TRAINING)
6. ☐ PROVOST MARSHALL
7. ☐ ENGINEERING
8. ☐ SUPPLY
9. ☐ NON-GOVERNMENT

2

32. CORRECTIVE ACTION TAKEN OR TO BE TAKEN (cc 45) (Coded by FOA) — 4

SECTION F – COMMERCIAL VESSEL MISHAPS (To be completed ONLY for navigation mishaps)

33. COAST GUARD LICENSE (cc 46)
1. ☐ YES 2. ☐ NO

34. NUMBER OF BARGES (cc 47-50) LOADED LIGHT

35. H.P. OF TOW (cc 51)
1. ☐ UP TO 1000
2. ☐ 1001-3000
3. ☐ 3001-5000
4. ☐ 5001-7500
5. ☐ 7501 AND UP

36. GROSS TONNAGE OF TOW (cc 52)
1. ☐ UP TO 6000 TONS
2. ☐ 6001-9000 TONS
3. ☐ 9001-12000 TONS
4. ☐ 12001-15000 TONS
5. ☐ 15001 AND OVER

37. COLLISION/MISHAP (cc 53-56)
1. ☐ COLLISION W/OTHER VESSEL
2. ☐ UPPER GUIDE WALL
3. ☐ UPPER LOCK GATES
4. ☐ LOCK WALL
5. ☐ LOWER LOCK GATES
6. ☐ LOWER GUIDE WALL
7. ☐ TOW BREAK UP
8. ☐ SWEPT DOWN ON DAM
9. ☐ BUOY OR DOLPHIN
10. ☐ WHARFS & DOCKS
11. ☐ OTHER

PRIMARY SECONDARY

38. NAVIGATION AIDS (cc 57)
1. SUPERVISED
2. NOT SUPERVISED

39. APPROACH (cc 58)
DOWN RIVER: 1. ☐ WAY ON 2. ☐ WAITING
UP RIVER: 3. ☐ WAY ON ☐ WAITING

BLANK (cc 59-79)

CARD NO. (cc 80) 3

Source: U.S. Army Corps of Engineers

U.S. Army Corps of Engineers ENG FORM 3394 page 4.

REPO[RT] [S]UBMISSION (cc 01)
1. ☒ [B]ASIC
2. ☐ SUPPLEMENTAL
3. ☐ CORRECTION

F[ILE] IDENTITY (cc 02-12)

	FOA		YR		MO		REPT NO			INJ NO	
1	G	3	8	Ø	1	2	Ø	2	4	Ø	Ø

SECTION G – OTHER INFORMATION

[40]. ACTIVITY FUNDED BY (Check appropriate box) (cc 13)

1. ☒ CIVIL WORKS
2. ☐ MILITARY CONSTRUCTION
3. ☐ AMMUNITION PRODUCTION BASE
4. ☐ POSTAL CONSTRUCTION
5. ☐ NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
6. ☐ GENERAL SERVICES ADMINISTRATION
7. ☐ OTHER (Specify)

1

41. CONTRACTOR/EMPLOYER (cc 14-38)

BLANK (cc 48-79): Ø436Ø ØGT

CARD NO. (cc 80): 4

41A. UNSAFE CONDITION (cc 39-41)	41B. UNSAFE ACT (cc 42-44)	41C. UNSAFE PERSONAL FACTOR (cc 45-47)
1 Ø Ø	Fail to Yield 2 3 8	Lack of Caution 3 Ø 1

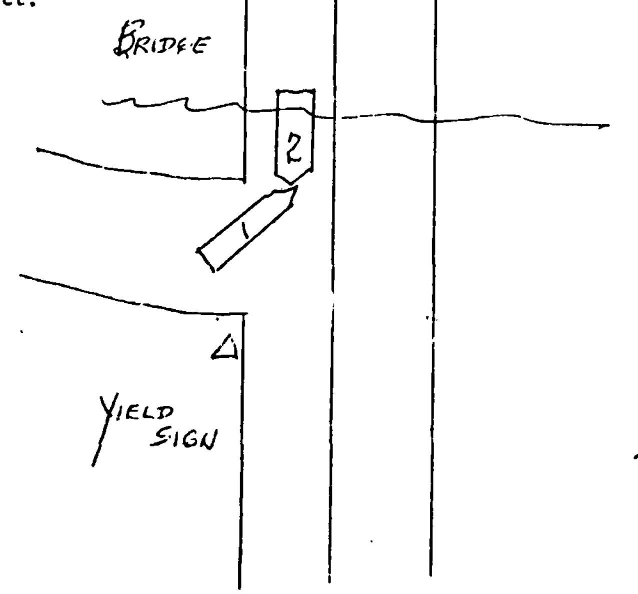
42. PREPARED BY (Print name and title)	SIGNATURE	DATE
William L. Harryman Vernon Howard	William L Harryman Vernon Howard	24 Dec 80

43. REVIEWED BY (Print name and title)	SIGNATURE	DATE
WILLIAM C. ALGUARD Chief, Project Operations Br.	WC Alguard	29 Dec 80

44. ANALYZED BY (Print name and title)	SIGNATURE	DATE
SAM L. MOORE, JR Chief, Safety Office	Sam L Moore Jr	30 Dec 80

REMARKS (Describe the why and how of the mishap and any other information pertinent to the analysis. Do not continue the NARRATIVE DESCRIPTION of mishap in this section)

Vehicle equipped with seat belts which were not being used. Operator disregarded requirement to use seat belts. Increased emphasis will be given this subject.



~~MOORE~~ SM

PEDERSON AP

Col ~~MORASKI~~

CORRECTIVE ACTION APPROVED BY (Print name and title)	SIGNATURE	DATE
LEON K. MORASKI ~~Colonel, Corps of Engineers~~ District Engineer		30 DEC 80

GPO 986-853

Source: U.S. Army Corps of Engineers

APPENDIX C

Definition of Columns within Army Corps of Engineers Data Base.

The column numbers and item names correspond to individual items from the Army Corps of Engineers Mishap Report (see Appendix B). The width (WDTH) and output (OPUT) refer to the actual size of the columns and data within the computerized data base. For example, column 57 contains an item called "DUTY" which has a column width of 1 character and an output of 1 character. Column 57 corresponds to Section A Item 6 on the first page of the mishap report.

COL	ITEM NAME	WDTH	OPUT	COL	ITEM NAME	WDTH	OPUT	COL	ITEM NAME	WDTH	OPUT
1	REC-TYP	1	1	90	TYPE-MISHAP	1	1	170	LIGHT	2	2
2	EROC	2	2	91	PHASE-CONST	2	2	172	HP	1	1
4	YEAR	2	2	93	MU-UTIL	1	1	173	TONNAGE	1	1
6	MONTH	2	2	94	AMT1	8	8	174	PRI	2	2
8	REPNO	3	3	102	AMT2	8	8	176	SEC	2	2
11	INJNO	2	2	110	AMT3	8	8	178	NAV-AIDS	1	1
13	NAME	36	36	118	AMT4	8	8	179	APPROACH	1	1
49	AGE	2	2	126	AMT5	8	8	180	FUND	1	1
51	SEX	1	1	134	SEVERITY	1	1	181	CONT-EMP	25	25
52	ASSIGN	4	4	135	DEATH	6	6	206	UNS-COND	3	3
56	CLASSIF	1	1	141	DAYS-LOST	4	4	209	UNS-ACT	3	3
57	DUTY	1	1	145	NAT-INJ	2	2	212	UNS-PERSON	3	3
58	GRADE	4	4	147	LOC-INJ	3	3	215	OSHA	3	3
62	OCCUP	4	4	150	CAUSE-INJ	2	2				
66	TIME-DUTY	2	2	152	MV-OWNER	1	1		** REDEFINED ITEMS **		
68	TRAINING	2	2	153	MV-TYPE	2	2	2	FILEID	11	11
70	SUP-PERS	1	1	155	AGENCY	2	2	2	DIV	1	1
71	SUP-SITE	1	1	157	TYPE	2	2	72	ACTIVITIES	5	5
72	ACTIVITY	4	4	159	PARTS	1	1	155	AGENCY-MISHAP	5	5
76	ACTIN	1	1	160	SAF-REQ	5	5	155	CODE	5	5
77	DATE	6	6	165	CORR-MEAS	1	1	2	EROC-YEAR-MONTH	6	6
83	TIME	4	4	166	CORR-ACT	1	1	79	DATE-D	2	2
87	STATE	2	2	167	CG-LIC	1	1	77	DATE-M	2	2
89	WEATHER	1	1	168	LOADED	2	2	81	DATE-Y	2	2

Source: U.S. Army Corps of Engineers.

The actual code contained within the column that represents "DUTY" was deciphered using the legend that was provided with the magnetic tape, a sample of which is depicted below.

```
DATAFILE NAME: DF-DUTY
   2 ITEMS: STARTING IN POSITION     1
COL  ITEM NAME           WDTH OPUT TYP N.DEC  ALTERNATE NAME
   1  DUTY                  1    1  L     0    D
   2  DESCRIPTION          20   20  C     -    DES
$RECNO    DUTY DESCRIPTION
      1     0     UNKNOWN
      2     1     ON DUTY ON POST
      3     2     ON DUTY OFF POST
      4     3     OFF DUTY ON POST
      5     4     OFF DUTY OFF POST
```

Source: U.S. Army Corps of Engineers

APPENDIX D

U.S. Bureau of Labor Statistics Producer Price Indexes.

Producer Price Indexes

NO. 768. PRODUCER PRICE INDEXES, BY STAGE OF PROCESSING: 1970 TO 1985

1967 = 100. Minus sign (−) indicates decrease

STAGE OF PROCESSING AND COMMODITY	1970	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Crude materials for further processing	**112.3**	**196.9**	**202.7**	**209.2**	**234.4**	**274.3**	**304.6**	**329.0**	**319.5**	**323.6**	**330.8**	**306.1**
Foodstuffs and feedstuffs	112.0	191.8	190.2	192.1	216.2	247.9	259.2	257.4	247.8	252.2	259.5	235.0
Nonfoods, exc. fuel	109.8	188.3	206.7	212.2	233.1	284.5	346.1	413.7	376.8	372.2	380.5	355.3
For manufacturing	109.6	192.4	211.6	216.8	238.2	292.7	357.4	429.4	387.2	381.9	390.1	360.5
For construction	113.9	151.1	161.2	170.6	185.7	207.0	237.6	261.8	270.3	270.6	278.7	285.8
Fuel	122.6	271.5	305.3	372.1	426.8	507.6	615.0	751.2	886.1	931.5	931.3	909.6
Manufacturing industries	116.9	252.1	300.1	384.6	446.2	549.6	690.5	864.9	1,034.8	1,094.5	1,092.2	1,063.2
Nonmanufacturing industries	130.2	297.2	317.1	370.9	421.1	485.0	567.0	674.0	782.2	816.3	818.1	802.1
Intermediate materials, supplies, components	**109.9**	**180.0**	**189.1**	**201.5**	**215.6**	**243.2**	**280.3**	**306.0**	**310.4**	**312.3**	**320.0**	**318.7**
Materials and components for manufacturing	110.0	178.7	185.4	195.4	208.7	234.4	265.7	286.1	289.8	293.4	301.8	299.5
Materials for—												
Food manufacturing	112.9	209.4	180.0	183.4	206.5	229.4	264.4	260.4	255.1	258.4	271.1	258.8
Nondurable manufacturing	103.8	174.7	184.2	190.0	196.7	222.8	259.5	285.8	284.4	280.0	290.5	285.9
Durable manufacturing	114.7	188.4	201.0	217.6	236.2	270.6	301.0	312.1	310.1	319.4	325.1	320.2
Components for manufacturing	111.1	158.3	166.6	176.8	189.6	207.5	231.8	259.3	273.9	280.4	287.5	291.5
Materials and components for construction	112.6	176.4	188.4	203.4	224.7	247.4	268.3	287.6	293.7	301.8	310.3	315.2
Processed fuels, lubricants	105.0	233.0	250.1	282.5	295.3	364.8	503.0	595.4	591.7	564.8	566.2	548.9
Containers	111.4	171.4	180.2	188.3	202.8	226.8	254.5	276.1	285.6	286.6	302.3	311.2
Supplies	108.0	168.1	179.0	188.7	198.5	218.2	244.5	263.8	272.1	277.1	283.4	284.2
For manufacturing industries	110.0	157.9	166.5	177.0	189.3	207.5	231.9	253.1	265.8	269.9	279.0	285.2
For nonmanuf. industries	107.2	173.4	185.5	194.8	203.3	223.8	251.1	269.6	275.7	281.1	285.9	284.0
Finished goods	**110.3**	**163.4**	**170.6**	**181.7**	**195.9**	**217.7**	**247.0**	**269.8**	**280.7**	**285.2**	**291.1**	**293.7**
Consumer goods	109.9	163.6	169.7	180.7	194.9	217.9	248.9	271.3	281.0	284.6	290.3	291.8
Foods	113.5	181.0	180.4	189.9	207.2	226.2	239.5	253.6	259.3	261.8	273.3	271.2
Crude foods	116.3	181.2	193.9	201.0	216.8	233.1	237.2	263.8	252.7	258.7	281.6	260.0
Processed foods	113.1	181.3	177.8	187.3	204.6	223.8	237.8	250.6	257.7	260.0	270.3	270.0
Other nondurable goods	109.3	163.0	174.8	189.3	200.0	231.3	283.9	319.6	333.6	335.3	337.3	339.3
Durable goods	106.9	138.2	144.5	152.8	166.9	183.2	206.2	218.6	226.7	233.1	236.8	241.5
Capital equipment	112.0	162.5	173.4	184.6	199.2	216.5	239.8	264.3	279.4	287.2	294.0	300.5
ANNUAL PERCENT CHANGE [1]												
Crude materials for further processing	**3.6**	**11.9**	**2.9**	**3.2**	**12.0**	**17.0**	**11.0**	**8.0**	**−2.9**	**1.3**	**2.2**	**−7.5**
Foodstuffs and feedstuffs	2.5	11.4	−.8	1.0	12.5	14.7	4.6	−.7	−3.7	1.8	2.9	−9.4
Fuel	15.0	17.2	12.4	21.9	14.7	18.9	21.2	22.1	16.0	5.1	-	−2.3
Intermediate materials, supplies, components	**3.9**	**10.4**	**5.1**	**6.6**	**7.0**	**12.8**	**15.3**	**9.2**	**1.4**	**.6**	**2.5**	**−.4**
Materials and components for—												
Manufacturing	4.0	10.2	3.7	5.4	6.8	12.3	13.4	7.7	1.3	1.2	2.9	−.8
Construction	1.6	9.4	6.8	8.0	10.5	10.1	8.4	7.2	2.1	2.8	2.8	1.6
Processed fuels, lubricants	6.6	17.3	7.3	13.0	4.5	23.5	37.9	18.4	−.6	−4.5	.2	−3.1
Finished goods	**3.5**	**8.2**	**4.4**	**6.5**	**7.8**	**11.1**	**13.5**	**9.2**	**4.0**	**1.6**	**2.1**	**.9**
Consumer goods	3.1	8.3	3.7	6.5	7.9	11.8	14.2	9.0	3.6	1.3	2.0	.5
Capital equipment	4.8	7.7	6.7	6.5	7.9	8.7	10.8	10.2	5.7	2.8	2.4	2.2

- Represents or rounds to zero

[1] For 1970, base year is 1969; thereafter change from prior year shown.

APPENDIX E

Raw Time of Day Data

CONUS

	1977	1978	1979	1980	1981	1982	1983	Totals
Death								
7 to 8	3	4	1	2	4	4	9	27
8 to 9	6	12	8	8	3	5	7	49
9 to 10	9	6	5	8	9	9	13	59
10 to 11	16	15	10	15	17	11	2	86
11 to 12	19	12	10	22	10	8	15	96
12 to 1	15	16	19	24	16	11	15	116
1 to 2	26	21	30	35	11	13	15	151
2 to 3	27	32	27	30	30	29	25	200
3 to 4	47	31	31	28	21	44	38	240
4 to 5	35	26	35	42	52	35	29	254
5 to 6	35	20	45	35	39	46	30	250
Else	128	119	105	121	111	100	88	772
Total	366	314	326	370	323	315	286	2300
Firstaid								
7 to 8	1	0	0	1	1	0	0	3
8 to 9	2	0	1	2	[illegible]	0	0	7
9 to 10	2	0	4	3	1	0	2	12
10 to 11	4	0	1	1	2	3	1	12
11 to 12	2	2	3	0	1	1	0	9
12 to 1	1	0	1	0	3	0	1	6
1 to 2	1	2	2	3	3	0	0	11
2 to 3	2	2	2	1	2	0	4	13
3 to 4	4	1	3	1	0	2	0	11
4 to 5	4	1	3	2	1	0	0	11
5 to 6	1	3	0	0	5	1	1	11
Else	10	6	3	8	3	5	4	39
Total	34	17	23	22	24	12	13	145
Lost Days (Returned)								
7 to 8	20	26	22	29	50	50	34	231
8 to 9	81	69	80	81	73	73	84	541
9 to 10	86	108	106	98	132	95	105	730
10 to 11	121	134	124	145	160	136	118	938
11 to 12	95	103	121	128	120	115	85	767
12 to 1	25	45	52	52	54	39	38	305
1 to 2	81	59	85	102	115	94	58	594
2 to 3	81	89	109	117	98	96	105	695
3 to 4	84	84	84	95	83	78	68	576
4 to 5	41	39	38	41	45	41	34	279
5 to 6	19	31	11	20	15	19	20	135
Else	78	85	129	157	134	113	86	782
Total	812	872	961	1065	1079	949	835	6573

	1977	1978	1979	1980	1981	1982	1983	Totals
Lost Days (Terminated)								
7 to 8	0	0	0	1	1	0	0	2
8 to 9	3	1	0	4	0	1	2	11
9 to 10	2	2	0	4	1	4	0	13
10 to 11	0	2	3	5	2	1	5	18
11 to 12	1	2	4	3	1	2	1	14
12 to 1	2	0	0	1	1	0	0	4
1 to 2	0	1	1	1	3	1	2	9
2 to 3	0	2	6	2	2	1	1	14
3 to 4	1	3	0	1	1	1	1	8
4 to 5	0	0	0	0	0	2	0	2
5 to 6	1	1	0	0	1	0	0	3
Else	1	7	3	2	1	3	0	17
Total	11	21	17	24	14	16	12	115
Medical Case (Returned)								
7 to 8	4	4	7	10	11	6	3	45
8 to 9	13	10	18	18	25	12	10	106
9 to 10	28	21	30	33	36	28	16	192
10 to 11	25	25	36	37	43	31	16	213
11 to 12	34	27	26	27	37	32	15	198
12 to 1	4	10	5	17	9	13	8	66
1 to 2	27	13	29	25	31	17	11	159
2 to 3	25	31	27	39	38	24	21	194
3 to 4	24	21	19	21	22	14	15	136
4 to 5	11	11	5	7	10	5	6	55
5 to 6	1	4	3	2	6	1	1	18
Else	17	15	17	20	26	17	6	118
Total	214	197	222	245	294	200	128	1500
Medical Case (Terminated)								
7 to 8	0	0	0	0	0	0	0	0
8 to 9	1	0	2	0	0	0	0	3
9 to 10	1	0	0	0	1	0	0	2
10 to 11	0	1	0	0	0	0	0	1
11 to 12	0	0	0	1	0	0	0	1
12 to 1	0	0	0	0	0	1	0	1
1 to 2	0	1	0	0	0	0	0	1
2 to 3	1	0	2	0	0	0	0	3
3 to 4	0	0	0	1	0	1	0	2
4 to 5	0	0	0	0	0	0	0	0
5 to 6	0	1	0	0	0	0	0	1
Else	1	1	0	0	1	1	0	4
Total	4	4	4	2	2	3	0	19

	1977	1978	1979	1980	1981	1982	1983	Totals
No Injury								
7 to 8	15	27	22	22	16	14	3	119
8 to 9	29	28	34	25	31	24	18	189
9 to 10	18	32	32	39	30	25	15	191
10 to 11	32	43	39	36	34	26	21	231
11 to 12	32	37	38	37	35	37	16	232
12 to 1	29	32	25	22	20	20	18	166
1 to 2	32	39	40	27	30	29	22	219
2 to 3	40	43	42	41	30	31	25	252
3 to 4	39	42	32	48	32	32	17	242
4 to 5	31	27	44	29	31	19	8	189
5 to 6	16	23	20	24	14	17	10	124
Else	131	123	94	128	103	73	59	711
Total	444	496	462	478	406	347	232	2865

Restricted Work								
7 to 8	0	0	0	0	0	0	0	0
8 to 9	0	0	0	0	1	0	0	1
9 to 10	1	3	0	0	0	0	0	4
10 to 11	4	0	4	1	0	3	3	15
11 to 12	3	2	1	0	0	2	0	8
12 to 1	0	0	0	0	0	0	0	0
1 to 2	0	1	1	0	2	0	3	7
2 to 3	3	3	2	0	2	0	1	11
3 to 4	0	0	1	1	0	2	0	4
4 to 5	2	0	0	0	0	0	0	2
5 to 6	0	0	1	0	0	0	0	1
Else	2	0	0	0	0	0	0	2
Total	15	9	10	2	5	7	7	55

Unknown								
7 to 8	0	1	0	0	1	3	1	6
8 to 9	1	0	0	0	4	3	2	10
9 to 10	0	0	0	2	3	5	3	13
10 to 11	0	0	1	2	6	4	1	14
11 to 12	0	0	0	1	5	4	4	14
12 to 1	3	0	0	2	8	2	0	15
1 to 2	0	1	0	1	5	9	3	19
2 to 3	0	1	0	0	6	2	2	11
3 to 4	2	0	0	3	8	4	0	17
4 to 5	0	0	1	2	4	3	1	11
5 to 6	0	0	0	0	4	1	4	9
Else	5	1	2	3	9	13	8	41
Total	11	4	4	16	63	53	29	180

NON-CONUS	1977	1978	1979	1980	1981	1982	1983	Totals
Death								
7 to 8	1	1	0	0	0	0	1	3
8 to 9	0	1	0	0	1	0	0	2
9 to 10	0	1	0	0	1	0	0	2
10 to 11	0	1	0	0	0	1	1	3
11 to 12	0	1	0	0	2	0	1	4
12 to 1	0	1	0	0	0	1	0	2
1 to 2	0	0	0	0	0	1	0	1
2 to 3	1	0	1	1	1	1	1	6
3 to 4	0	1	0	0	2	1	2	6
4 to 5	0	0	2	0	0	2	0	4
5 to 6	1	0	0	0	0	1	0	2
Else	1	1	0	1	5	4	1	13
Total	4	8	3	2	12	12	7	48
Firstaid								
7 to 8	0	1	0	0	1	0	0	2
8 to 9	0	0	0	0	2	0	0	2
9 to 10	1	0	0	0	1	2	0	4
10 to 11	1	0	0	0	2	2	1	6
11 to 12	0	1	0	0	0	1	0	2
12 to 1	0	0	0	1	1	0	0	3
1 to 2	1	0	0	0	0	0	0	1
2 to 3	0	0	1	0	0	1	0	2
3 to 4	0	0	1	1	0	0	0	2
4 to 5	0	0	1	0	0	1	0	2
5 to 6	0	0	0	0	0	1	0	1
Else	0	0	0	5	6	4	0	16
Total	3	2	3	5	13	12	1	42
Lost Days (Returned)								
7 to 8	10	2	10	10	10	11	10	63
8 to 9	13	9	11	14	16	10	22	95
9 to 10	16	11	15	17	12	13	10	94
10 to 11	12	4	13	26	22	20	15	112
11 to 12	13	5	5	20	14	12	11	80
12 to 1	3	7	4	3	3	3	2	25
1 to 2	6	5	11	23	19	8	11	83
2 to 3	9	6	15	18	16	12	25	101
3 to 4	12	10	18	10	21	28	15	114
4 to 5	8	12	9	16	21	21	12	99
5 to 6	0	4	8	4	9	7	6	38
Else	13	13	10	28	28	22	15	134
Total	120	88	129	189	191	167	154	1038

	1977	1978	1979	1980	1981	1982	1983	Totals
Lost Days (Terminated)								
7 to 8	1	1	0	1	1	1	1	6
8 to 9	0	0	0	0	1	1	2	4
9 to 10	0	0	0	0	0	1	1	2
10 to 11	0	0	0	0	2	1	1	4
11 to 12	2	0	0	0	0	2	1	5
12 to 1	0	0	0	0	0	1	1	2
1 to 2	1	1	0	1	0	1	0	4
2 to 3	0	0	0	0	0	0	1	1
3 to 4	0	0	0	0	0	0	2	2
4 to 5	0	0	0	0	2	1	0	3
5 to 6	1	0	0	0	0	0	0	1
Else	2	0	0	0	1	1	0	4
Total	7	2	0	2	7	10	10	38
Medical Case (Returned)								
7 to 8	1	0	0	2	1	0	0	4
8 to 9	0	1	1	1	2	0	0	5
9 to 10	1	3	2	4	2	0	0	12
10 to 11	1	0	0	2	2	2	0	7
11 to 12	0	1	1	2	1	1	0	6
12 to 1	0	0	0	1	1	0	0	2
1 to 2	1	0	1	1	0	2	0	5
2 to 3	1	2	0	4	1	0	1	9
3 to 4	2	2	2	1	1	3	0	11
4 to 5	1	1	1	2	0	1	0	6
5 to 6	0	0	0	2	1	0	0	3
Else	1	1	2	5	5	2	0	16
Total	9	11	10	27	17	11	1	86
Medical Case (Terminated)								
7 to 8	0	0	0	0	0	0	0	0
8 to 9	0	0	0	0	0	0	0	0
9 to 10	0	0	0	1	0	0	0	1
10 to 11	0	0	0	0	0	0	0	0
11 to 12	0	1	0	0	0	0	0	1
12 to 1	0	0	0	0	0	1	0	1
1 to 2	0	0	1	0	0	0	0	1
2 to 3	0	0	0	0	0	0	0	0
3 to 4	0	0	0	0	0	1	0	1
4 to 5	0	0	0	0	1	0	0	1
5 to 6	0	0	0	0	0	0	0	0
Else	0	0	0	0	2	0	0	2
Total	0	1	1	1	3	2	0	8

	1977	1978	1979	1980	1981	1982	1983	Totals
No Injury								
7 to 8	2	7	10	10	12	7	10	58
8 to 9	3	5	3	15	6	10	5	47
9 to 10	4	8	8	24	16	12	6	78
10 to 11	10	13	6	22	17	9	2	79
11 to 12	7	13	1	13	15	11	7	67
12 to 1	2	5	9	9	5	4	7	41
1 to 2	6	6	7	12	6	3	12	52
2 to 3	3	11	4	14	15	13	5	65
3 to 4	3	7	10	24	16	9	7	76
4 to 5	3	8	7	19	16	12	6	71
5 to 6	2	11	7	13	12	6	6	57
Else	10	25	22	60	41	41	25	224
Total	55	119	94	235	177	137	98	915
Restricted Work								
7 to 8	0	0	0	0	0	0	0	0
8 to 9	1	0	0	0	0	0	0	1
9 to 10	0	0	0	0	0	0	0	0
10 to 11	0	0	0	0	0	0	0	0
11 to 12	1	0	0	1	0	0	0	2
12 to 1	0	0	0	0	0	0	0	0
1 to 2	0	0	0	0	0	0	0	0
2 to 3	0	0	0	0	0	1	0	1
3 to 4	0	0	0	0	0	0	0	0
4 to 5	0	1	0	0	0	0	0	1
5 to 6	1	0	0	0	0	0	0	1
Else	1	0	0	0	0	0	0	1
Total	4	1	0	1	0	1	0	7
Unknown								
7 to 8	0	1	1	0	1	2	0	5
8 to 9	0	0	0	0	1	0	0	1
9 to 10	0	0	0	0	0	0	1	1
10 to 11	0	1	0	1	2	2	1	7
11 to 12	0	0	0	0	0	3	0	3
12 to 1	0	0	0	0	0	1	1	2
1 to 2	1	0	0	0	1	1	0	3
2 to 3	0	0	0	0	0	0	0	0
3 to 4	0	0	0	0	1	1	0	2
4 to 5	1	0	0	0	1	4	0	6
5 to 6	0	0	0	0	1	1	0	2
Else	0	0	0	0	4	3	1	8
Total	2	2	1	1	12	18	4	40